FR3® Technical Perspectives

Using the enhanced loading capacity of Cargill's FR3® fluid immersed transformers to optimize inventory.

The increased thermal class of paper immersed in Cargill's FR3® fluid allows for a relevant additional permanent overloading capacity, a "reserve capacity" that expands the application range of the transformers.

For same operating temperatures, paper degradation rate is 7.4x lower for thermally upgraded kraft paper (TUK or TUP). Alternatively, the same degradation rate is reached when the operating temperature is increased in 20°C. The additional degrees will offer an "above nameplate" capacity without accelerated degradation, named as "sustainable peak capacity".

The required minimum efficiencies, typically, lead to transformer not reaching specified temperature limits. So, there is some embedded "capacity reserve", as nominal life happens at a loading above rated.

Exploring these aspects allows designing "dual rated" transformers. Such units have a rated capacity, at conventional temperatures, and as additional loading capacity for higher temperature limits. Two different options for combining SKUs area possible. The system will verify both and suggest the best one.

Option A ⟶

Standard kVA values	FR3 fluid Dual Rating 1ϕ	Standard kVA values	FR3 fluid Dual Rating 3ϕ
10kVA 1ϕ 15kVA 1ϕ	**10/15 kVA**	30 kVA 3ϕ 45 kVA 3ϕ	**30/45 kVA**
25kVA 1ϕ 37.5kVA 1ϕ	**25/37.55 kVA**	75 kVA 3ϕ 112.5kVA 3ϕ	**75/112.5 kVA**
50kVA 1ϕ 75kVA 1ϕ	**50/75 kVA**	150 kVA 3ϕ 225 kVA 3ϕ	**150/225 kVA**
100kVA 1ϕ 167kVA 1ϕ	**100/167 kVA**	300 kVA 3ϕ 500 kVA 3ϕ	**300/500 kVA**
250kVA 1ϕ 333kVA 1ϕ	**250/333 kVA**	750 kVA 3ϕ 1000 kVA 3ϕ	**750/1000 kVA**

Option B ⟶

Standard kVA values	FR3 fluid Dual Rating 1ϕ	Standard kVA values	FR3 fluid Dual Rating 3ϕ
15kVA 1ϕ 25kVA 1ϕ	**10/15 kVA**	45 kVA 3ϕ 75 kVA 3ϕ	**45/75 kVA**
37.5kVA 1ϕ 50kVA 1ϕ	**25/37.55 kVA**	112.5 kVA 3ϕ 150 kVA 3ϕ	**112.5/150 kVA**
75kVA 1ϕ 100kVA 1ϕ	**50/75 kVA**	225 kVA 3ϕ 300 kVA 3ϕ	**225/300 kVA**
167kVA 1ϕ 250kVA 1ϕ	**100/167 kVA**	500 kVA 3ϕ 750 kVA 3ϕ	**500/750 kVA**

Differently from a "standardization" process, where a larger transformer replaces a smaller one, the concept is to extend the application range of the smaller one.

Since peak capacity is only reached a few hours per day, some days per year, the balance of the reduction of the no-load losses 24/7 and the increase of the load losses during peak may lead to an equivalent or even lower value of dissipated energy. USA DOE reports (Department of Energy) from 2019 indicated yearly RMS average load of distribution transformers to be around 30%, while the optimum would be 50%. So, this approach improves the transformer utilization, getting closer to best efficiency and asset utilization.

Reduction of inventory

It is a common practice to add about 15% of "margin" on the number of units to be purchased per year for each SKU. When SKU's are combined, this reserve is only added to the item having more consumption, not to the total. The quantity of purchased transformers will be thus reduced.

Financial assumptions

For illustrative purposes, some reference costs for each transformer was assumed. Starting from an estimated price in the middle of the range, the price of other rated capacities was calculated proportionally to the square root of the capacity variation, i.e., the price of a 75kVA was sqrt(75/50) = 1.225x the price of a 50kVA.

An additional assumption was that the price of the dual rating unit was 10% higher than the price of the base original rated capacity.

Expected benefits

This approach is expected to allow both reducing the number of SKU's and the average cost per kVA. In case you want to refine the values, **Contact us - FR3fluid.com**

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